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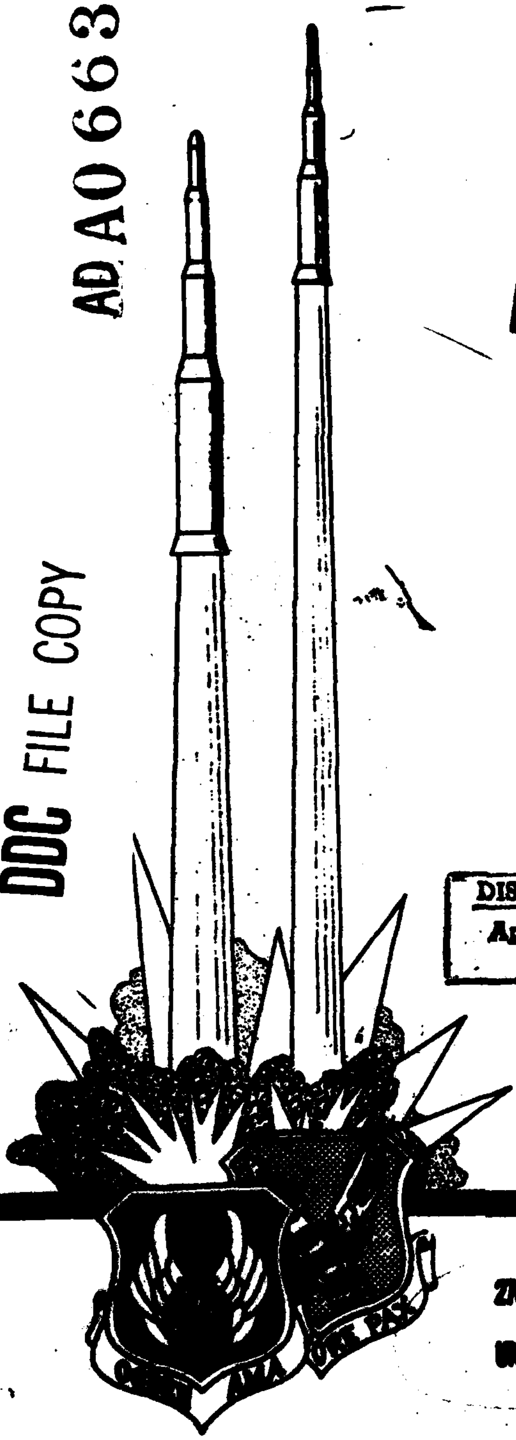

OOAMA

AIRMUNITIONS TEST REPORT

MINUTEMAN (LGM-30) IMPALER TEST

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2705th AIRMUNITIONS WING
UNITED STATES AIR FORCE

OGDEN AIR MATERIEL AREA
HILL AIR FORCE BASE, UTAH

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MINUTEMAN (LGM-30)

IMPALER TEST

By

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and

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PUBLICATION REVIEW

This report has been reviewed and recommended for approval

Nile W. Harbertson

NILE W. HARBERTSON
Chief, Missiles and Space
Systems Branch (OOYEG)

Approved for release

JAMES O. DAVENPORT, JR
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2705th Airmunitions Wing

MAY 1966

2705TH AIRMUNITIONS WING
OGDEN AIR MATERIEL AREA (AFLC)
UNITED STATES AIR FORCE
Hill Air Force Base, Utah

OOY-TR-66-509

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ADMINISTRATIVE DATA

PURPOSE OF TEST:

The purpose of this test was to evaluate a single bladed punch type impaling device used in OOAMA Missile Assembly Maintenance Shops (MAMS). This device was designed to prevent escape of and to render non-propulsive Minuteman motors if accidently ignited. The motors were tested in a separated configuration. This configuration was considered to be one of the worst configurations from the standpoint of successful impaler operation.

TYPE OF IMPALER TESTED:

Federal Stock Number 1450 955 3030AH

Part Number 63TOGD199

SECURITY CLASSIFICATION:

Unclassified

DATE TEST COMPLETED:

12 April 1966

TEST CONDUCTED BY:

OOAMA, 2727th Airmunitions Test Squadron (OOYT)

Project Officer: David Anderson, 2d Lt USAF (OOYTO-T)

Project Engineer: Don F. Woods (OOYEG)

Test Directive: M-6-509-G (OOYEG)

STANDING OPERATING INSTRUCTION: 127-83

DISPOSITION OF TEST RESIDUE:

Propellant fragments were collected and burned. Nonexplosive Materiels, Case Fragments etc, have been collected and will be stored about 90 days. They will be turned into salvage when no longer required for evaluation.

ABSTRACT

The purpose of this test was to evaluate a single bladed punch type impaling device used in OOAMA Missile Assembly Maintenance Shops (MAMS). Minuteman Missiles are returned from Operational sites to OOAMA for maintenance work which is accomplished in MAMS. During recycle the three motor stages are placed on wheeled carriages that roll on a rail system within the MAMS. A single bladed punch type impaler is positioned between the rails at the front of the building. The purpose of this device is to render the motors non-propulsive if accidental ignition should occur.

A test was devised simulating the MAMS condition to verify the ability of the impaler to perform as intended. Test rails were erected and three motor stages were mounted on carriages. Destruct packages were mounted on each motor. These devices were designed to automatically destroy the motor after five seconds if the impaler was not effective. The motors were spaced seven and one half feet apart. The third stage motor was also seven and one half feet from the impaler.

The first stage (rear) motor was ignited using the motor igniter. The motor and carriage moved straight down the rails impacting the second stage motor. The forward dome of the first stage motor ruptured. Both motors and their carriages moved down the rails until the second stage impacted the third stage knocking it from its carriage and on to the impaler. The second stage and third stage motors burned from both ends and moved off of the rails. These motors traveled 44 and 122 feet respectively. The first stage motor remained at the end of the rails. All motors burned out completely.

The interaction of the impacting motors coupled with the impaler rendered all motors non-propulsive. The impaler performed its function very effectively.

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INTRODUCTION

Minuteman Missiles (less reentry system) are returned from Operational sites to OOAMA for maintenance work. The recycle work is accomplished in Missile Assembly Maintenance Shops (MAMS). Missile motors are placed on wheeled carriages (one for each motor stage). The carriage wheels roll on steel rails in MAMS. (Figures A and B).

In order to comply with safety regulations, a restraining device must be incorporated in the rails system to cause the motors to become non-propulsive if accidently ignited. The restraining method used in MAMS, in Boeing assembly buildings and in most Storage Igloos at OOAMA is a punch type, single bladed impaler attached to four steel legs. This device is mounted at the front end of the rails. It is designed to impact and penetrate the forward dome near the center of the front motor. Since this impaling device had never been tested under full scale conditions, a test was designed to simulate an accidently ignited motor during recycle in MAMS and to determine if the impaler would perform its intended function.

The test directive M-6-509-G was prepared by the Missile and Space System Branch (OOYEG). The test was conducted by the 2727th Airmunitions Test Squadron (OOYT) and followed Standing Operating Instruction 127-83.

TEST CONFIGURATION

GENERAL:

Figure 1 is a schematic drawing of the test configuration. Figure 2 is a photograph of the actual set up. Three solid propellant motors (stage one, two and three) were mounted on carriages and placed on rails about five feet above the ground. Wheel chocks were placed against the carriage wheels. A destruct package was designed for the test and was attached to each motor. One impaler was mounted to the end of the rails. The stage one motor was ignited by means of the normal ignition system. High speed cameras were used to photograph the results.

MOTORS:

One first, second and third stage operational configuration motors were used in the test. The first and second stage motors were Wing I design. The third stage motor was Wing II design.

The first stage motor weighs about 50,000 pounds, it is about 5½ feet in diameter and 24½ feet long. Four moveable nozzles provide control when the missile is in flight. The motor contains a solid, composite propellant. The case is steel covered with avcoat insulation.

The second stage motor weighs about 12,000 pounds. It is about four feet in diameter and 14 feet long. Four moveable nozzles provided direction control. The solid propellant is a composite type. The case is steel covered with avcoat.

The third stage motor weighs about 4,000 pounds. It has a fiber glass case and contains a double base propellant. The case insulation is cork. Four moveable nozzles provide direction control.

The normal pyrogen igniter and KR80000 Safe and Arm Devices (S&A) were used with each motor. The first stage S&A Device was armed to allow normal electrical ignition of the motor. The S&A Devices in the second and third stage motors were not armed.

The motors were positioned on the rails in the sequence that they are recycled in MAMS (first, second and third stage and the impaler). The impaler is at the entrance of the MAMS.

The spacing between each motor (forward dome to nozzle expansion cone exit plane) was seven and one half feet. The forward dome of the third stage motor was also seven and one half feet from the impaler.

The temperature of the motors was initially at 60°F. The ambient temperature during the morning of the test had been predicted to be below 60°F (the minimum firing temperature). Therefore, prior to testing, the motors were temperature conditioned at 100°F for about 65 hours. This conditioning was calculated to result in a temperature of about 75°F on the internal surface of the propellant grain. The time between removing the motors from temperature conditioning and static firing was about five hours. This time would not appreciably lower the temperature on the internal surface of the grain below 75°F.

The nozzle control units and shipping links were not used in the test. No attempt was made to align the four nozzles of each motor to any particular position after removing the shipping links.

DESTRUCT SYSTEM:

The test was planned to be conducted without the use of restrains attached to the motors or without the motors covered by netting or barricaded in any manner. It was felt that such devices, if used, might bias the outcome of the test.

In order to prevent possible flight of the test motors in the event that the impaler failed to cause the motors to be non-propulsive, a destruct system was designed, fabricated and installed on each motor (Figures 3 thru 5).

The destruct system consisted of strips of 200 grain per foot lead covered, RDX core, flexible, linear shaped charge (FLSC) connected to five second delay blasting caps. It was calculated that the time from first stage motor ignition to impact of the third stage motor with the impaler would be approximately eight tenths of one second. The five second delay time was therefore, chosen to allow enough time for significant action to occur and yet not allow a motor to travel further than five miles if free flight occured.

Three destruct packages were attached to each motor. The strips of FLSC were five feet in length. Two lengths of FLSC with blasing caps at one end were bonded to the forward and aft "Y" joints of the first and second stage motors. The two strips per "Y" joint were butt jointed in the middle. Two strips of FLSC were used down the second stage raceway. Four strips were used down the first stage raceway (the two center strips did not have blasting caps attached). One strip of FLSC with blasting caps at both ends was bonded to both "Y" joints and to the raceway of the third stage. This procedure resulted in six blasting caps per motor. This gave a redundancy of six since the functioning of any one blasting cap would have opened up the motor. The FLSC assemblies were bonded to the motor and were covered with General Electric RTV 88 adhesive.

Eighteen, five second delay blasting caps (six per stage) were connected in parallel with the fire line to the first stage S&A Device squib circuits. Thus any fire pulse reaching the S&A Device would also activate the five second delay caps eliminating the possibility that first stage ignition could occur without activating the destruct system.

This automatic five second delay destruct system was chosen over one with command destruct capability or motion sensing capability as it was simple and reliable in design and did not require transmitters or receivers or any motion sensing devices. It eliminated the possibility, that a motor might become airborne without a means to destroy it because of a failure in a component of a command or motion sensing destruct system.

CARRIAGES:

Two types of motor carriages were used. The first and third stage motors were mounted on yellow R&D carriages. The second stage motor was mounted on a blue Operational carriage. The most significant difference between the yellow R&D carriages and the blue Operational carriage is weight.

The first stage R&D carriage weighs 3,500 pounds as compared to 2,878 pounds for the production carriage. The third stage R&D carriage weighs 1,240 pounds as compared to 608 pounds for the production carriage. The weight saving was achieved by extensive use of aluminum in the production carriage. It is considered that the test results were not appreciably affected by the use of the first and third stage R&D carriage as the net weight difference is small.

The vertical and horizontal restraining bands were removed from the carriage. Thus the motors were held on their carriages only by weight and friction.

RAILS:

The test rails consisted of two 20 foot sections of Boeing rails (identical with those used in MAMS) and two 20 foot sections of OOAMA designed and fabricated rails (total 80 feet). The rails were five feet high and five feet wide. They were optically aligned and anchored on a 150 foot by 50 foot concrete pad. The front section of Boeing rail had drilled mounting holes to allow mounting of the impaler.

The OOAMA designed rails were essentially the same as the Boeing rails but were fabricated with a lighter top rail and used a steel angle as the track for the carriages. This design reduced the cost of the rails as the machined top surface of the Boeing rail design was avoided.

WHEEL CHOCKS:

Wheel chocks were placed against two diagonally opposed wheels of each carriage (two chocks per carriage). The chocks were located in front of the forward wheel and diagonally behind the aft wheel. The chocks used for the second and third stage carriage were identical to those used in MAMS. The chocks used for the first stage motor were slightly modified to allow use on the OOAMA designed rails. The clamping bolt for each shock was hand tightened as much as possible.

IMPALER:

The impaler (Figure 6) consisted of a steel head supported by four steel legs. A hardened steel point was silver soldered into the head. The impaler has been designed to mount between the rails and to pivot downward to allow passage of motor carriages.

The impaler was mounted at the front of the Boeing rails in the identical manner to those used in MAMS. Standard Mounting Plates and bolts were used. The point of the impaler was 24¼ inches above the top of the rails.

CAMERAS:

The test was photographed by Fastax and Photsonic cameras operating between 750 - 1,000 frames per second. The cameras were equipped with two, 10, 15 and 32 inch telephoto lenses. The cameras were elevated above the plane of the test by 20 to 500 feet. Camera results were excellent. Movie film showing the test results after burn out were obtained using a hand held 16mm camera.

BLAST GAUGES:

Bikini type blast gauges were used to record any over pressure that might have developed. Aluminum foil of 0.001 inch thickness was used in the gauges. These gauges were positioned "face on" (Figure 7).

PRELIMINARY TESTING

BLASTING CAPS:

During the design of the destruct system it was apparent that the blasting caps might function early due to shock from impacting motors or by heat from burning propellant.

The blasting caps used were a commerical type of electrical delay cap using DIAZO and PETN explosive. In order to determine their sensitivity to shock initiation, five caps were dropped from a height of 40 feet on to a steel plate in various orientations. The caps did not function, one cap was taped onto a two pound rock and dropped from a height of 40 feet with the rock on the bottom. The cap did not function.

The five delay caps were then functioned electrically. All caps functioned normally. The delay times were between 5.3 and 5.7 seconds.

It was concluded that the shock from impact of one motor with another would probably not cause the caps to function prematurely.

To prevent the blasting caps from being overheated, they were covered with a thick layer of RTV 88 adhesive.

FLSC:

Two preliminary tests were performed to verify that the FLSC would cut open the motor cases. Strips of FLSC were taped to the forward dome and side of an empty first stage motor case, also to the forward and aft dome and along the raceway of an empty third stage motor case.

The FLSC was initiated with an engineers special blasting cap. The 200 grain per foot FLSC cleanly cut thru the two cases.

It was concluded that the FLSC was completely adequate to open the motor case.

TEST FIRING SEQUENCE

A portable instrumentation package containing power supplies, relays and a sequencer was dug in and barricaded about 1,000 feet from the test pad. This instrumentation package was operated remotely from a blockhouse. The sequencer was programmed to provide a three second camera run up time before first stage motor ignition.

The first stage safe and arm device was armed and the armed conditioned verified by an electrical monitoring circuit. The sequencer was then activated starting the cameras and three seconds later igniting the first stage motor.

TEST RESULTS

TIME SEQUENCE OF EVENTS:

EVENT	EVENT TIME(SEC)	ACCUMULATIVE TIME(SEC)
Fire Signal	0	0
First Stage Ignition	.068-.091	.068-.091
First Stage Motion	.076-.101	.144-.192
Impact-1st and 2d Stage	.245-.327	.389-.519
Flame-1st Stage FWD Dome	.043-.057	.432-.576
Impact-2d and 3d Stage	.078-.104	.512-.680
Flame-3d Stage Aft	.031-.042	.541-.722
Impact-3d Stage with Impaler	.071-.095	.612-.817
Flame-3d Stage Forward Dome	0	.612-.817
FWD Motion of 3 Stage Stopped	.535-.713	1.147-1.530

TABLE 1. Event Times.

FIRST STAGE MOTOR:

After ignition, the motor and carriage moved forward together pushing the forward wheel chock out of the way. The motor impacted the aft end of the second stage motor fracturing the second stage nozzle expansion cones. The motor continued forward until the first stage S&A unit impacted with, dented and cracked the center of the second stage aft closure. Impact of the forward dome with the nozzle expansion cones, undoubtedly weakened the dome but there was no evidence that cone splinters actually penetrated the dome. The first stage motor sustained a severe pressure burst at the forward end upon impact with the second stage.

The forward dome fractured and failed all around the outer periphery. Radical cracks also occurred resulting in a failure pattern resembling pie segments. Almost all segments of the forward dome were recovered (Figure 8). They were found in a 360° pattern. A three foot by three foot section was found 1,500 feet from the rails approximately 45° northwest. This was the furthest test fragment found. Apparently burning pieces of propellant were attached to the dome fragments as burned areas were found close to the impact points of the metal fragments. The burning propellant apparently tore loose from the fragments upon impact. The forward carriage wheels dented the rails on each side and a heavy angle rail cross brace was bent forward.

First stage motor thrust was reduced almost to zero after the forward dome blew out. The motor and carriage together with the second stage motor and carriage moved down the rails until the second stage impacted the third stage. Then the third stage impacted with the impaler tearing it from the rails. The first stage motor and carriage come to rest with the front carriage wheels at the end of the rails. The motor case was almost completely consumed. The only intact or recognizable portion was the aft closure and nozzle assembly (Figure 9).

There was no evidence that any of the shaped charges mounted on the first stage motor functioned. The shaped charge around the aft closure burned away without detonating, as evidenced by a burned path in the aft closure insulation, to which the shaped charge had been attached. The forward dome fragments collected were not cut by shaped charges (Figures 10 and 11). There was no positive way to determine if the case down the raceway was cut as the entire cylindrical portion of the case was consumed. However, if this raceway charge did detonate it would have occurred after the forward dome ruptured as the high speed cameras did not reveal any action along the raceway up to the time that this area was enveloped in flames from the burning front end.

SECOND STAGE MOTOR:

Impact from the first stage motor caused failure and fragmentation of all nozzle expansion cones (Figure 12). The center of the aft closure was dented and cracked from impact with the first stage S&A Device. The motor and carriage moved down the rails together with the first stage motor and carriage. The wheel chocks were pushed out of the way.

It was difficult to determine if the second stage started to burn in the aft end (ignited by the flame from the first stage forward dome area) as this area was enveloped in flames from the first stage motor. If the aft end was burning, flame or smoke did not at this time progress to the forward dome portion of the case.

The second stage motor impacted the third stage motor. The impact of the nozzle expansion cones weakened the second stage forward dome. The third stage motor probably ignited. The second stage motor forward dome fragmented and blew out.

A section of the forward dome was found 206 feet in front of the rails (Figure 13). This was an 18 inch diameter fragment from the center of the case containing the S&A Device and the pyrogen unit. The internal rubber liner was attached. The pyrogen unit and all internal surface of the fragment were unburned and free from the smoke deposits. The outer surface of the fragment and the S&A Device were heavily blackened. This indicated that the outer surface had been exposed to flame and that the forward dome had fragmented before the propellant in the second stage motor had started to burn at the front end of the motor.

The second stage motor knocked the third stage motor from its carriage, the second stage motor left its carriage and landed on the third stage carriage. The second stage motor in the third stage carriage, now burning from both ends, followed the third stage motor off the rails and landed about 44 feet in front of and slightly to the right of the rails. The propellant burned out of the case, the case was almost consumed except for a section at the bottom and the aft closure. The aft closure fell away from the main case portion and was found immediately behind the case (Figure 14).

The shaped charge around the front "Y" joint functioned cutting the remaining portion of the dome. These fragments were found at the final resting place of the motor indicating that the shaped charge had functioned after the motor came to rest. The shaped charge around the aft "Y" joint did not function as evidenced by the intact aft closure and nozzle assembly. There was no evidence that the shaped charge along

the raceway functioned. However, since the case was almost completely consumed this cannot be positively determined.

The second stage carriage left the rails and landed just in front of and slightly to the right of the rails. This carriage was almost consumed by fire from the burning propellant (Figure 15).

THIRD STAGE MOTOR:

The impact from the second stage motor appeared to cause the third stage motor to ignite in the aft end, as this part of the motor was enveloped in flames. It cannot be positively determined if the aft part of the third stage or the forward part of the second stage initiated the flames. However, the second stage forward dome segment containing the S&A Device and pyrogen igniter was blackened on the outside and not burnt on the inside. Therefore, the most probable explanation was that the third stage motor ignited on impact blackening the forward dome of the second stage.

The third stage nozzle expansion cones fractured. The motor was knocked from its carriage and the nose dropped below the original centerline. The motor impacted the impaler slightly above center at about a 30° nose down attitude. Immediately upon impact with the impaler, the motor forward dome ruptured and was enveloped in flames. Probably the impaler did not cause ignition but its penetration weakened the dome allowing the internal pressure from the burning motor to blow out the dome.

The motor cartwheeled past the impaler. Two nozzle inserts were blown forward of the rails and two were blown behind the rails (Figure 16). The impaler was torn from its mounts and dropped down in front of the rails (Figure 9). The motor, burning from both ends, moved forward a distance of about 122 feet (Figure 17). A large section of propellant fell out of the case and burned separately about 150 feet from the impaler end of the rails. Between the front of the rails and the final resting place, the shaped charge around the forward "Y" joint functioned, cutting the remaining portion of the dome away from the case (Figure 18). The shaped charge along the raceway burned away without detonating since a portion of the intact raceway was found. It cannot be positively determined if the shaped charge around the aft "Y" joint detonated or burned away as the case was badly burned in the area (Figure 17).

DEBRIS:

Much burning propellant was thrown from the motors and several large pieces burned in the immediate area of the test pad. Burned patches on the ground were visible out to about 1,50C feet (mostly West and North).

Small pieces of unburned propellant were scattered about the test pad and in the area.

Figure 19 is a map showing the location of the major metal fragments. Other small pieces and fragments were scattered among the major fragments. As can be seen from the map, almost all debris was thrown West and North ahead of the test pad with very few fragments being thrown behind the pad. Figure 20 includes photographs showing the relation of the major motor case fragments to the test rails.

CONCLUSION

No detonation occurred. The first stage motor did experience a pressure burst that yielded a 2-3 psi overpressure at the 100 foot radius. The second and third stage motors burned out with only minor pressure bursts.

An overpressure of 2-3 psi inside a MAMS would cause many of the light weight outside wall and roof panels to be blown loose from the building. It is unlikely; however, that any of these panels would travel as far as another building.

The interaction of impacting motors and penetration of the impaler into the third stage forward dome caused all three motors to become non-propulsive. The major motor fragments and almost all debris were found within the 740 feet spacing of MAMS.

The distance traveled by many of the fragments would be reduced from the results of this test if accidental ignition occurred in MAMS. Many fragments would be stopped within the building after impacting with the concrete dividing wall or structural steel sections. These substantial building members would remain intact after the outer building panels were blown away by overpressure.

The destruct charges did not significantly affect the outcome of the test. The charges that cut the second and third stage forward domes did so after the motors had cleared the rails and were already burning from both ends.

It is likely that the interaction of impacting motors and of the forward motor with the impaler would render the motors non-propulsive in all configurations of separated motors within MAMS.

There is also a high probability that the impaler would be effective in preventing escape of all stages of an assembled missile. However, it is difficult to draw reliable conclusions between an assembled missile

and the separated configuration as tested. The interaction between motors held apart by interstages would undoubtedly be different from those of the configuration tested.

The test was conducted in open air. During recycle the motors are inside a building. Impact of a pressurized motor with any substantial building component (structural steel, plumbing, concrete walls, floor, etc) would, in all probability, cause pressure burst and a non-propulsive motor. Thus, the building provides considerable added insurance that assembled motors if accidently ignited would be rendered non-propulsive.

Although the impaler has not been tested in conjunction with assembled missiles, the assembled condition of a missile is considered to be the least likely time for inadvertent motor ignition to occur for the reasons specified below:

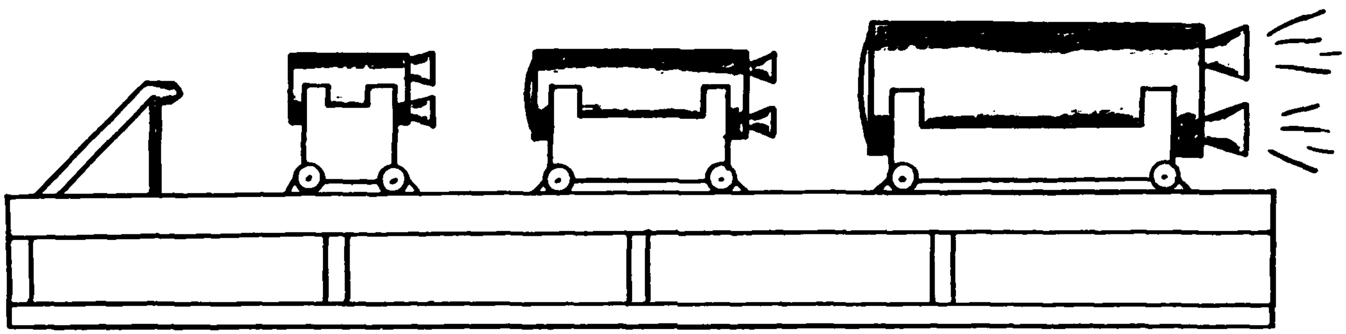
a. The motor S&A Devices are in a mechanically safe condition making it impossible to electrically arm them inadvertently. This condition is checked before a missile leaves a missile site and is verified upon arrival of the missile at OOAMA.

b. Safe and Arm Devices are not tested nor are they removed from or installed in the missile.

c. The time spent in working on an assembled missile in MAMS is short as compared with the time spent in working on separated stages. Therefore, the time that accidental ignition can occur in assembled missiles is short; thus, reducing the risk.

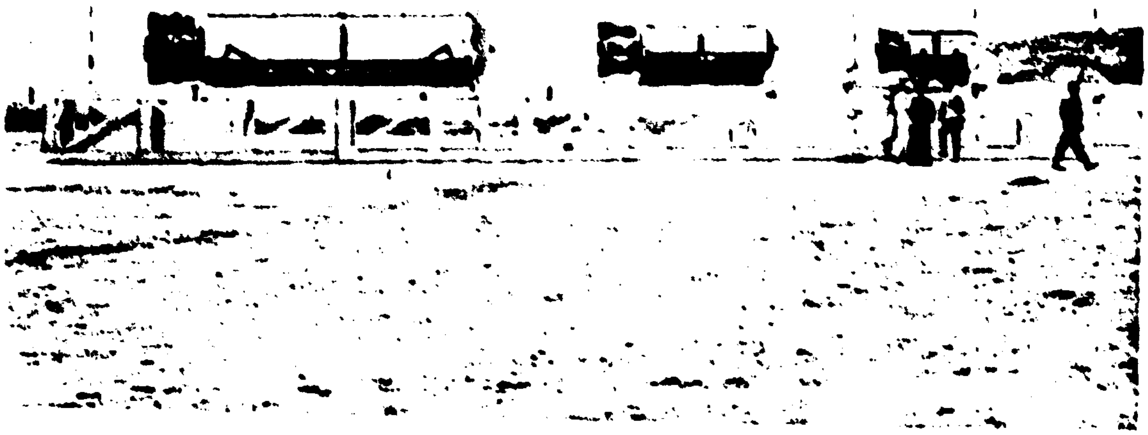
RECOMMENDATIONS

It is recommended that the use of impaler (FSN 1450-955-3030AH) as presently installed in MAMS be continued.



NOTE: SPACING BETWEEN THE NOZZLE EXIT CONE AND DOME OF MOTORS AND BETWEEN THE IMPALER AND THIRD STAGE DOME WAS 7½ FEET.

F I G U R E 1. TEST CONFIGURATION



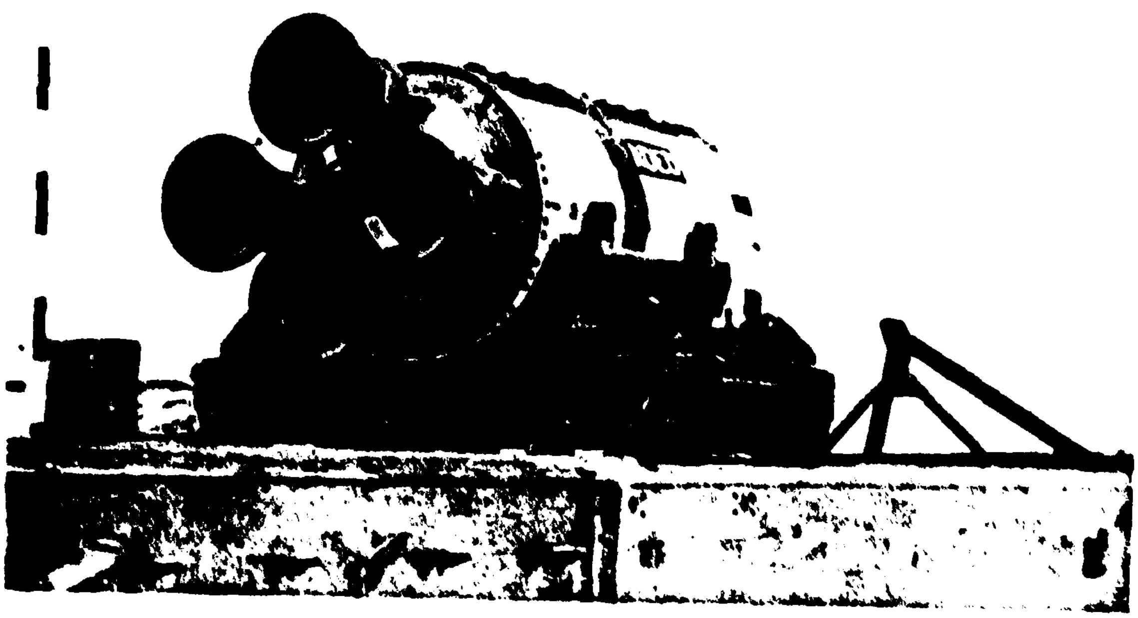
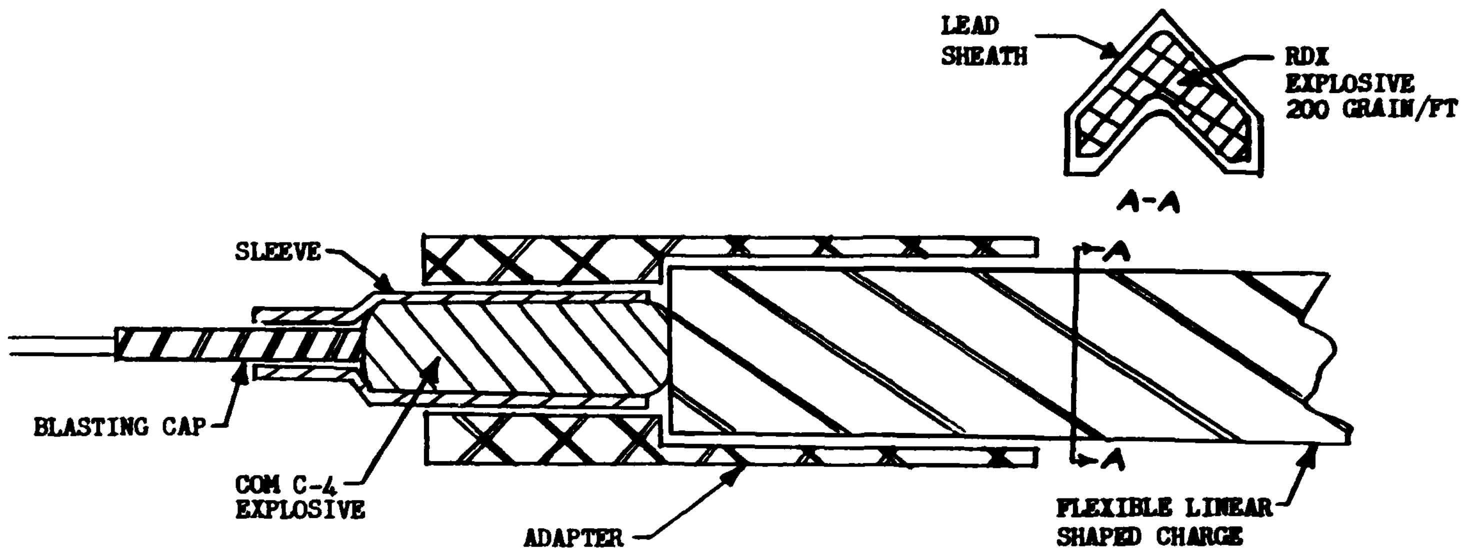


FIGURE 2. TEST SET UP AND IMPALER.

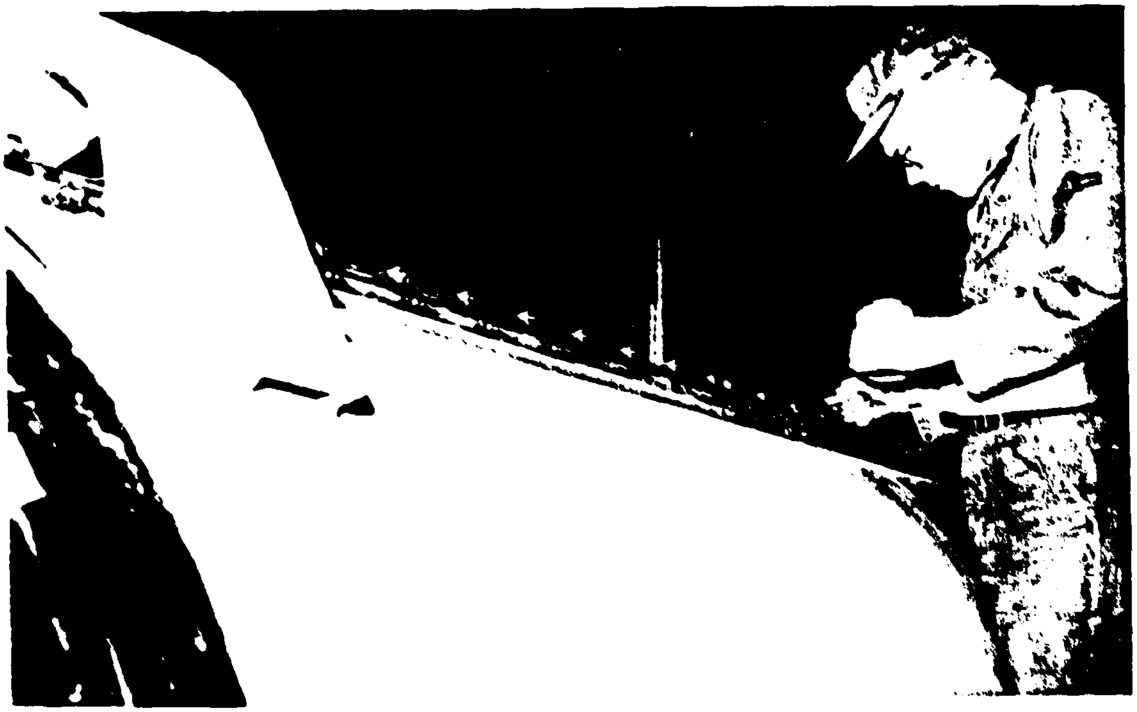


NOTE 1: SLEEVE BONDED TO BLASTING CAP WITH REN EPOXY ADHESIVE

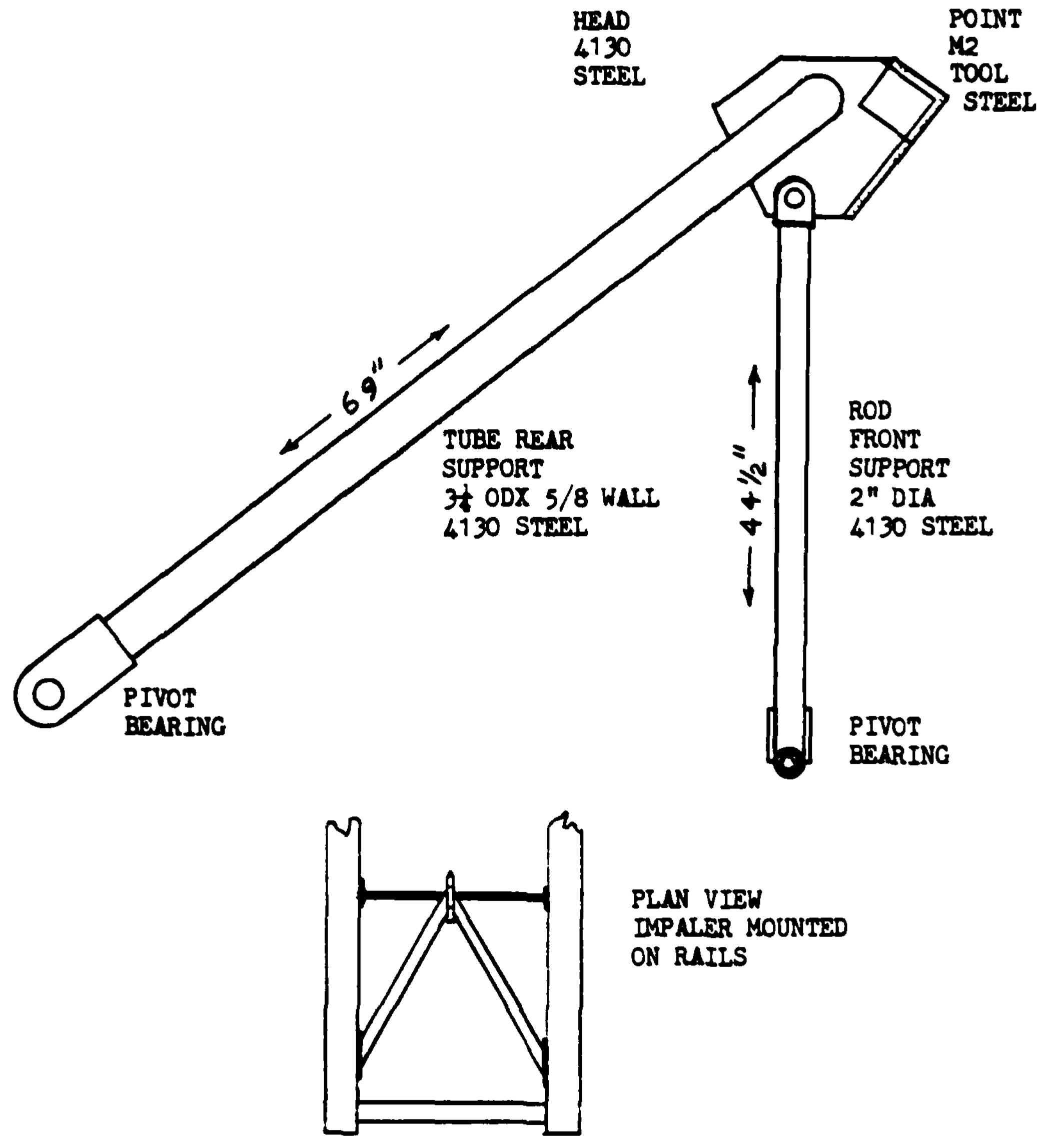
NOTE 2: BLASTING CAP ASSEMBLY AND FLSC BONDED TO ADAPTER WITH REN EPOXY ADHESIVE

F I G U R E 3. 5 SECOND DELAY BLASTING CAP - SHAPED CHARGE ASSEMBLY

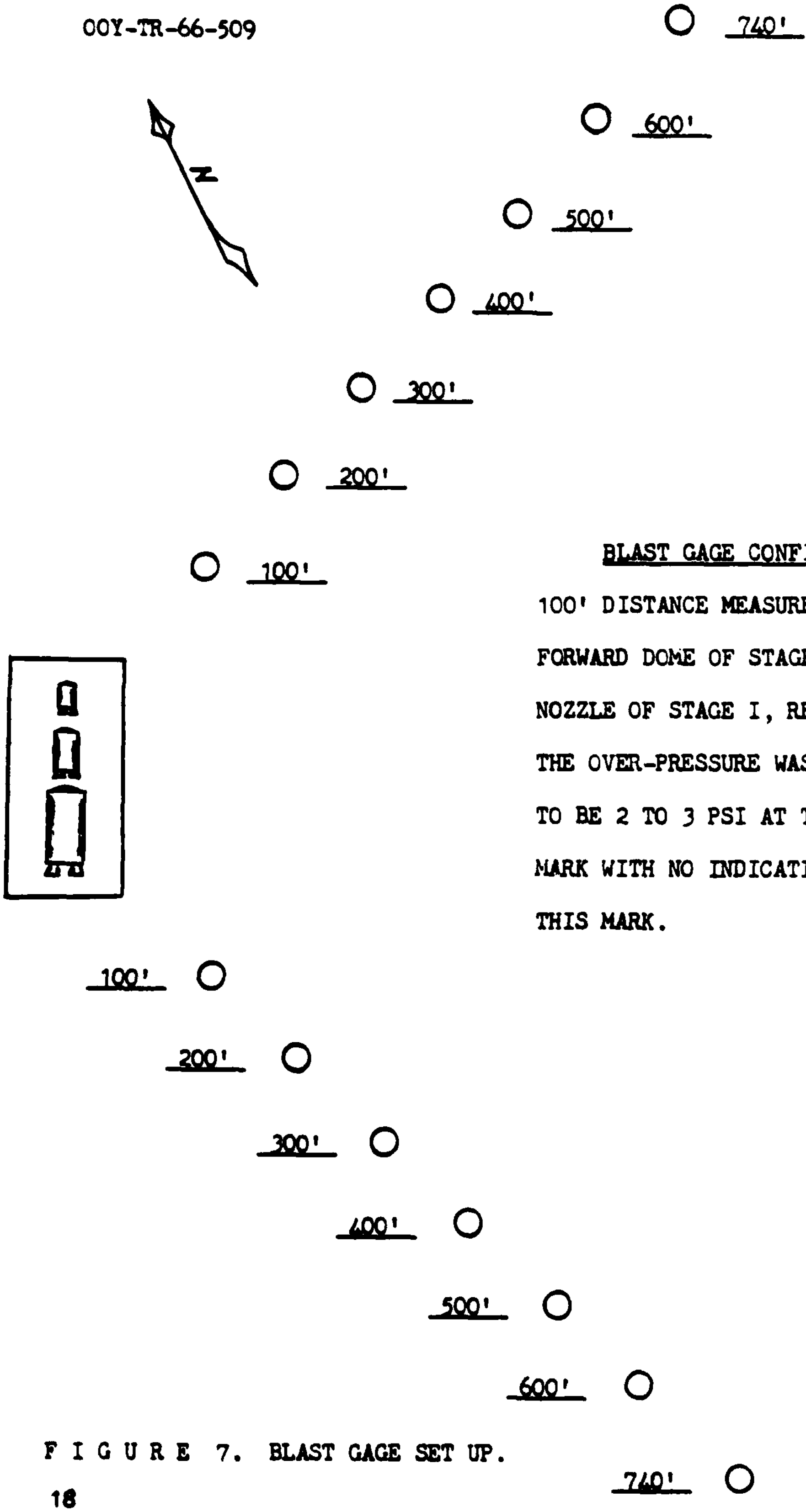
F I G U R E 4. INSTALLATION OF FLSC ON 1st STAGE MOTOR.



F I G U R E 5. APPLYING RTV 88 ADHESIVE TO FLSC.



F I G U R E 6. IMPALER

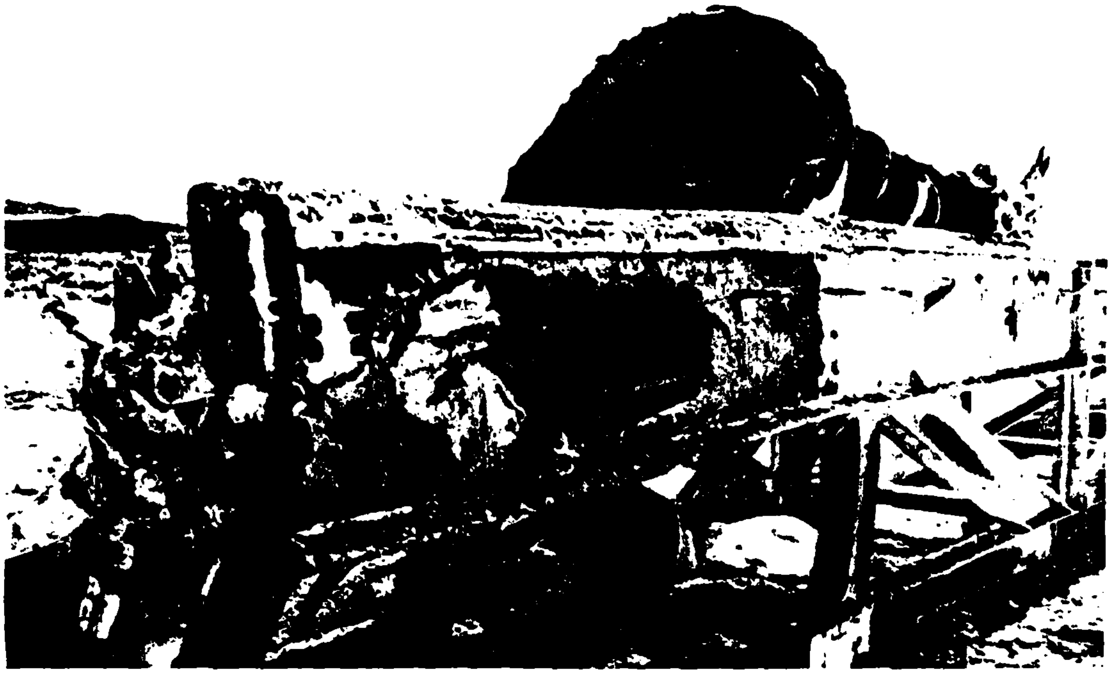


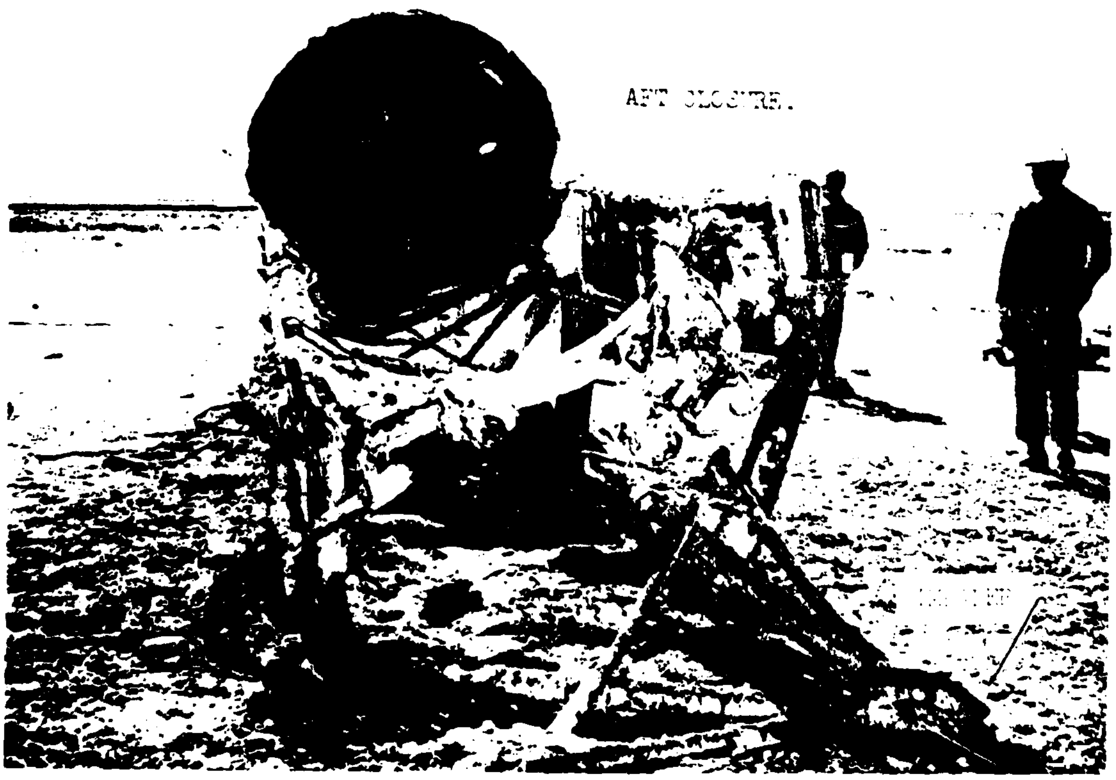
BLAST GAGE CONFIGURATION

100' DISTANCE MEASURED FROM FORWARD DOME OF STAGE III AND NOZZLE OF STAGE I, RESPECTIVELY. THE OVER-PRESSURE WAS CALCULATED TO BE 2 TO 3 PSI AT THE 100' MARK WITH NO INDICATION BEYOND THIS MARK.

FIGURE 7. BLAST GAGE SET UP.

F I G U R E 8. FRAGMENTS FROM 1st STAGE FORWARD DOME.





F I G U R E 9. 1st STAGE MOTOR AND IMPALER.

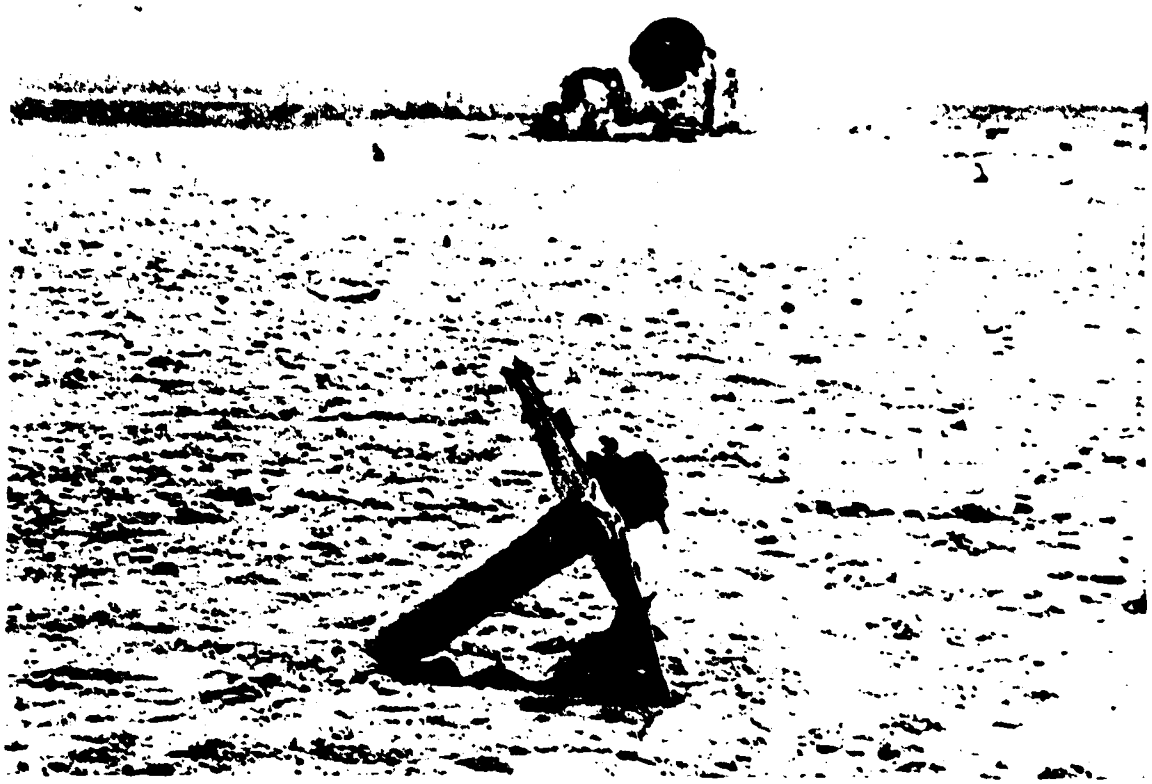
CIRCUMFERENTIAL AND RADIAL FAILURE EDGE EXIBIT 45° SLOPE. EDGE DOES NOT SHOW EVIDENCE OF CURLING OR DEFORMING AS OCCURS WHEN CUTTING METAL WITH OVER STRENGTH SHAPED CHARGE.

F I G U R E 10. 1st STAGE DOME FAILURE.

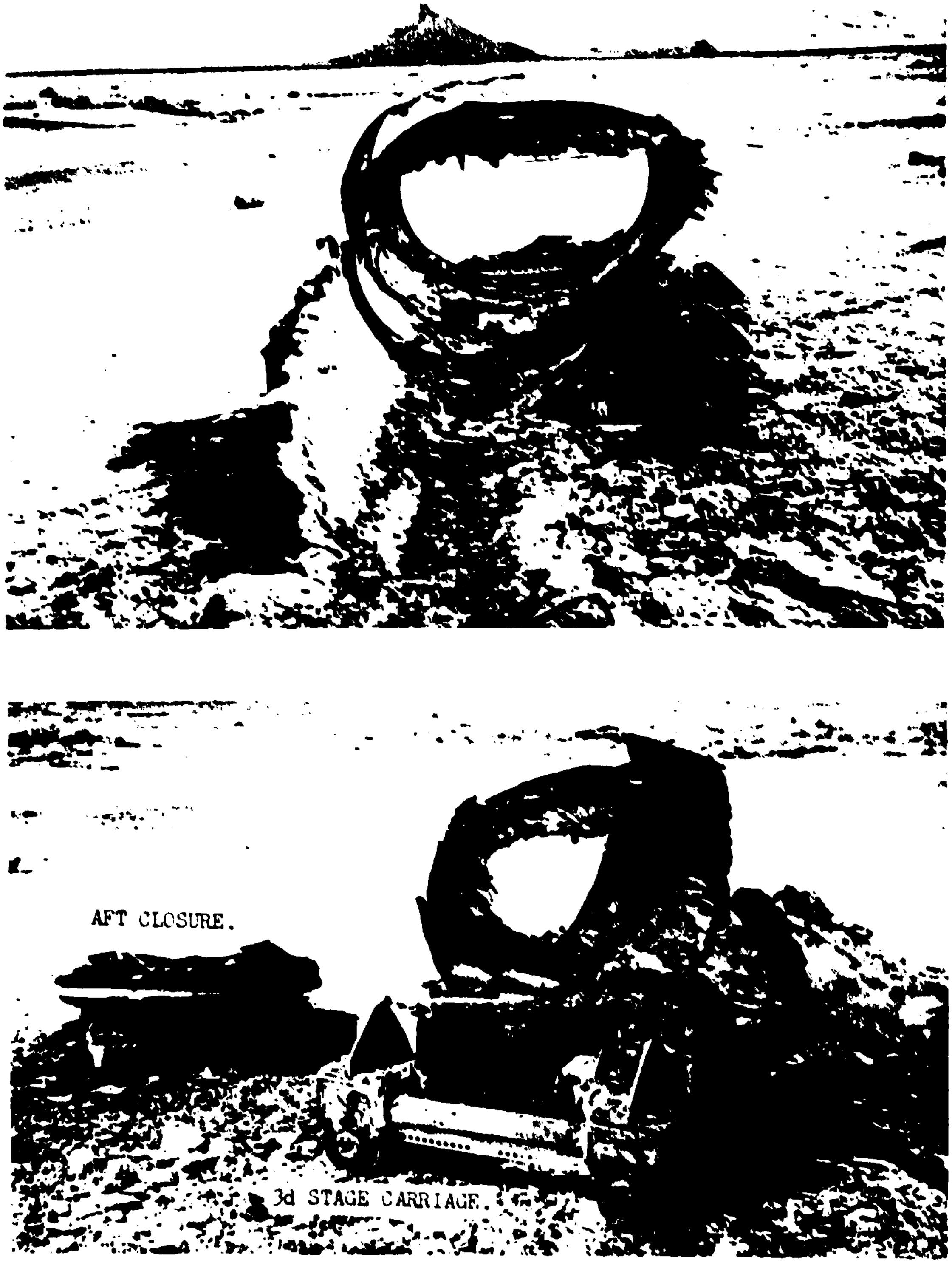
SHAPED CHARGE WAS INSTALLED WITH TOP OF "V" AGAINST SKIRT. SKIRT IS NOT GROOVED FROM FLSC BACK BLAST NOR IS LEAD SPATTER PRESENT AS WOULD HAVE OCCURRED IF FLSC HAD FUNCTIONED.

F I G U R E 11. 1st STAGE SKIRT FRAGMENT.

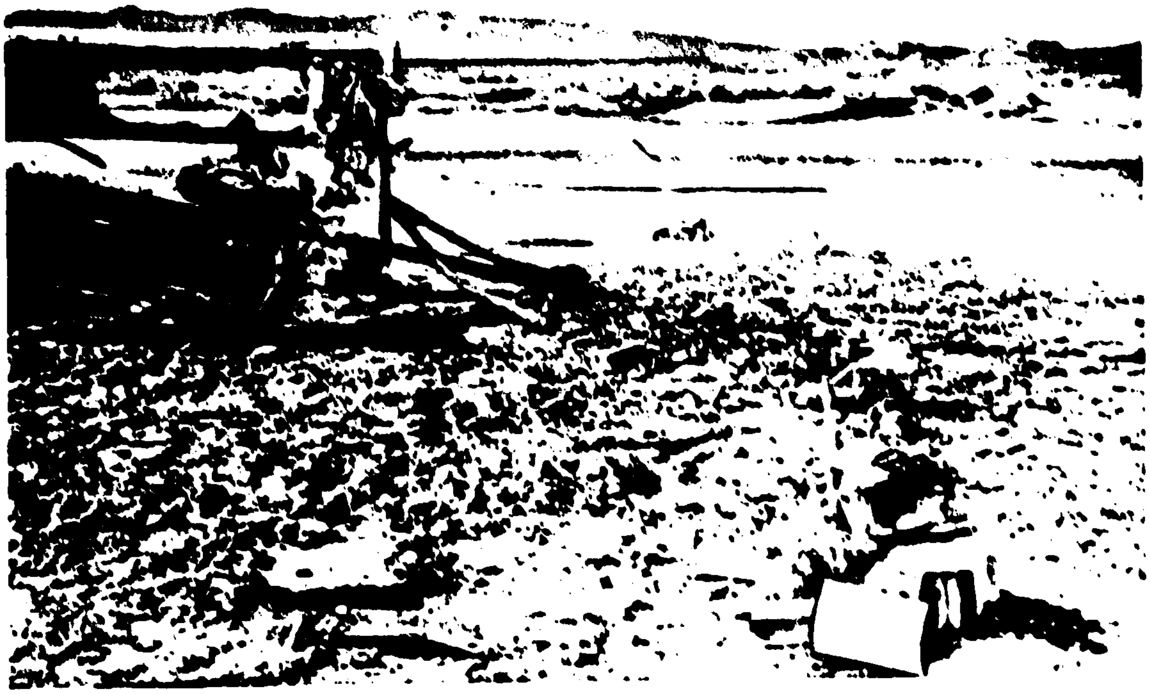
F I G U R E 12. NOZZLE EXPANSION CONE FRAGMENT.



F I G U R E 13. 2d STAGE PYROGEN AND S&A DEVICE.



F I G U R E 14. 2d STAGE MOTOR.



F I G U R E 15. 2d STAGE CARRIAGE.

F I G U R E 16. 3d STAGE NOZZLE INSERT.

F I G U R E 17. 3d STAGE MOTOR.

F I G U R E 18. 3d STAGE SKIRT CUT BY FLSC.

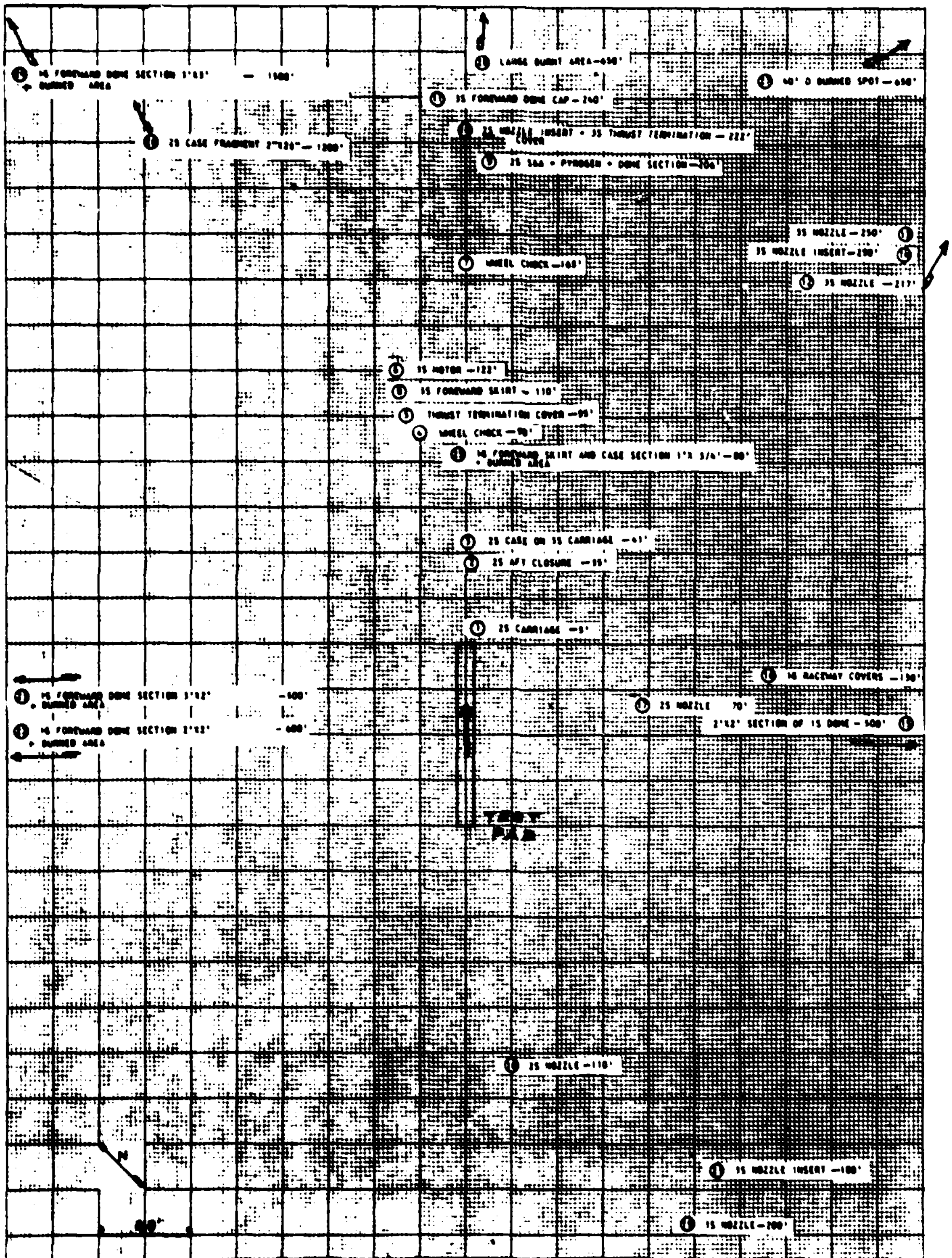
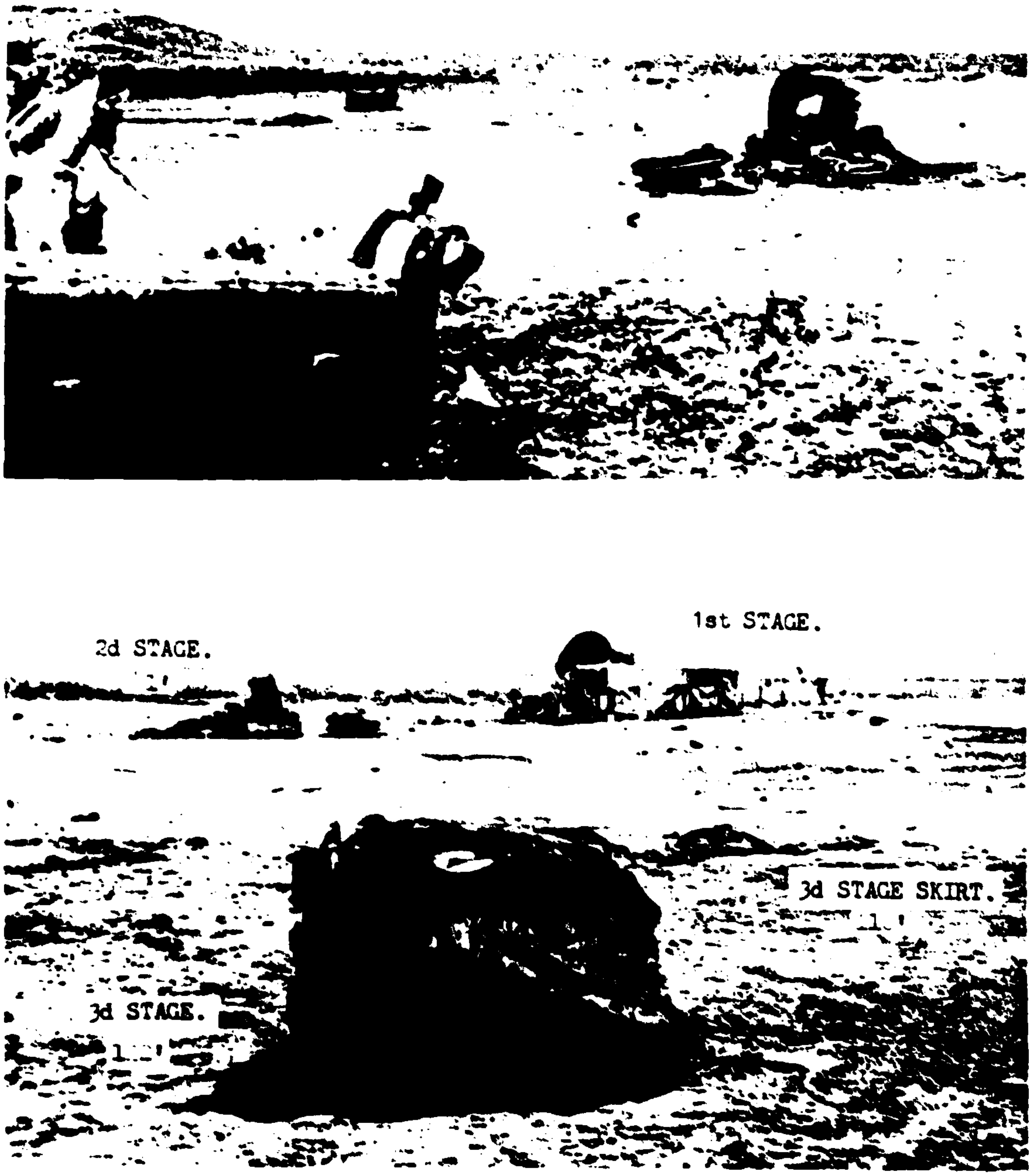
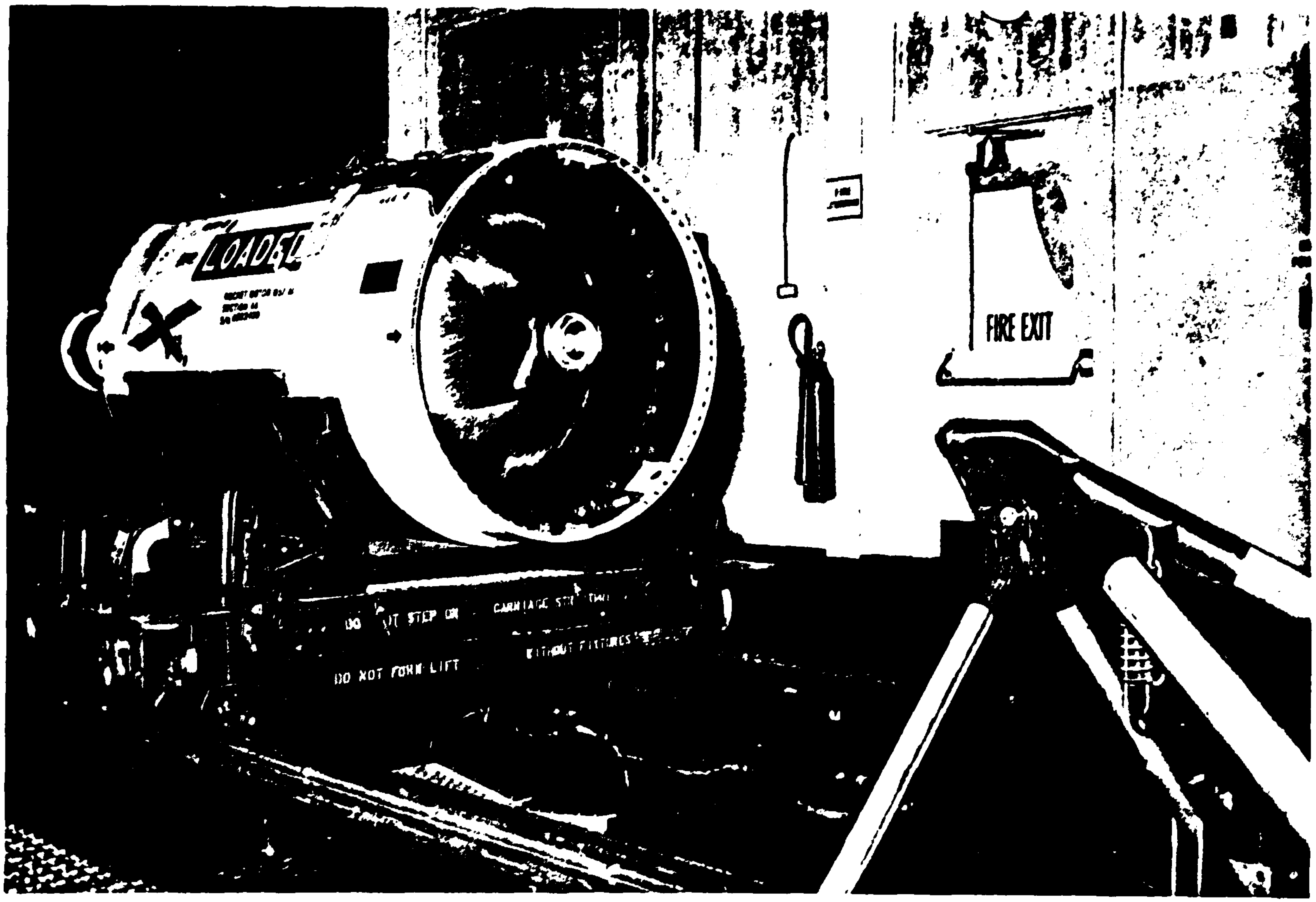


FIGURE 19. FRAGMENTATION MAP.



F I G U R E 20. MAJOR FRAGMENTS.

FIGURE A. MOTORS IN A MAMS



F I G U R E 8. IMPALER AND THIRD STAGE MOTOR IN A MAMS

DISTRIBUTION LIST

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1	Com US Nav Ord Test Stn (Code 84), China Lake, Calif 93555
1	Com Gen, US Army Mat Comd (AMCAD-S), Wash DC 20315
1	DA Ofc of the Chief of Engineers (ENGMC-EM), Wash DC 20315
2	Dep, TIG USAF (AFIAS-G2), Norton AFB, Calif 02409
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20	DDC (TISIR), Cameron Stn, Alexandria, Va 22314
1	Hq AFSC (SCMMS-3), Andrews AFB, Wash DC 20331
1	Hq MATS (MAMSS/WW), Scott AFB, Ill 62226
29	OOAMA (1-OOBA, 1-OOK, 1-OOM, 1-OOMD, 1-OOME, 1-OOMM, 1-OOMP, 1-OOMQ, 1-OONE, 2-OONC, 2-RWHO, 1-OOTM, 9-OOYEG, 1-OOYEO, 1-OOYIM, 2-OOYS, 1-OOYSTA, 1-OOYTP), Hill AFB, Utah 84401
1	SAC (DM4E), Offutt AFB, Nebr 68113
2	US Army Missile Comd (AMSMI-SMC), Redstone Arsenal, Ala 35809
1	US Nav Propellant Plant (Tech Lib), Indian Head, Md 20640
1	Tech Tng Cen (TS-SS), Sheppard AFB, Tex 76311

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2705th Airmunitions Wing (OOAMA), Hill Air Force Base, Utah
MINUTEMAN (LGM-30) IMPALER TEST, by Don F. Woods and John K. Scambia, May 1966, 32p incl. figures.
(OOY-TR-66-509) Unclassified Report

The purpose of this test was to evaluate a single bladed punch type impaling device used in OOAMA Missile Assembly Maintenance Shops (MAMS). During recycle the three motor stages are placed on wheeled carriages that roll on a rail system within MAMS. A single bladed punch type impaler is positioned between the rails at the front of the building. The purpose of this device is to render the motors non-propulsive if accidentally ignited.

A test was devised simulating the MAMS condition to verify the ability of the impaler to perform as intended. Test rails were erected and three motor stages were mounted on carriages. Five second delay destruct packages were mounted on each motor. The motors were spaced seven and one half feet apart.

The first stage rear motor was ignited. The motor and carriage moved straight down the rails impacting the second stage motor. The forward dome of the first stage motor ruptured. Both motors and their carriages moved down the rails until the second stage impacted the third stage knocking it from its carriage and on to the impaler. The second stage and third stage motors burned from both ends and moved off of the rails. These motors traveled 44 and 122 feet respectively. The first stage motor remained at the end of the rails.

The interaction of the impacting motors coupled with the impaler rendered all motors non-propulsive. The impaler performed its function very effectively.

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